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1-1-2006

EOS spheres, Vol. 5, Issue 2 (Spring 2006)

University of New Hampshire. Institute for the Study of Earth, Oceans and Space

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Recommended Citation

University of New Hampshire. Institute for the Study of Earth, Oceans and Space, "EOS spheres, Vol. 5, Issue 2 (Spring 2006)" (2006). *EOS Spheres*. 14.
<https://scholars.unh.edu/spheres/14>

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EOS SPHERES

Institute for the Study of Earth, Oceans, and Space • A University of New Hampshire Research Institute • Morse Hall, Durham, NH

Undergraduates Showcase Research

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Joe Hollweg Packs Up

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Spring 2006

Vol. 5 Issue 2

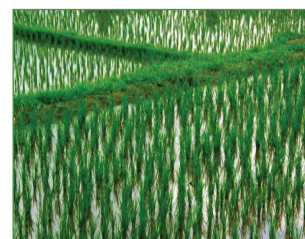
A Bird's-Eye View of Avian Flu

EOS scientists Xiangming Xiao and Steve Frolking use remote sensing to help track the disease

USING A SATELLITE in orbit 705 kilometers above the Earth to track a microscopic virus might seem a little like using a backhoe with a six-foot bucket to find a needle in a haystack. But the use of remote sensing to track and manage the spread of the Highly Pathogenic Avian Influenza (HPAI, subtype H5N1) has increased along with fears the disease could become a worldwide pandemic.

Scientists Xiangming Xiao and Steve Frolking of the Complex Systems Research Center (CSRC) are using data from the MODerate-resolution Imaging Spectroradiometer (MODIS) aboard NASA's Terra

and Aqua satellites to help the United Nations' Food and Agriculture Organization (FAO) better understand the global ecology of avian influenza – in particular its association with agricultural land use and wild waterfowl migration.



tion with agricultural land use and wild waterfowl migration.

In a nutshell, their technique is based on knowledge that free-ranging ducks play an important role in the

spread of the virus in Thailand, and that it is common practice for farmers to herd large populations of the fowl into freshly harvested rice paddy fields. The free-ranging ducks, who do not fall ill with the infection, serve as hosts/reservoirs for the H5N1 virus and can infect other domestic poultry, wild migratory birds, and humans susceptible to the disease's potentially deadly consequences. The free-ranging duck farming system is largely concentrated in those regions with two or three paddy rice cultivations per year, which provides ducks with food and water throughout a year at low cost.

Xiao and colleagues at CSRC developed novel algorithms to map and monitor paddy rice agriculture in Asia, using MODIS data, as part of other NASA-funded projects studying greenhouse gas emissions from paddy rice. In collaboration with animal health expert Jan Slingenberg

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Free-ranging ducks, like these in Thailand, play an important role in the spread of avian flu.

Spin Doctors

Sounding rockets give graduate students soup-to-nuts experience and access to space

SARAH JONES' PH.D. WORK has her head spinning. She's designing a camera that must take clear, accurate images of pulsating auroras from a rocket spinning at a rate of 60 revolutions per minute some 750 kilometers above Earth. Her camera, in other words, must twirl at a rate exactly opposite the sounding rocket in order to "despin" the digital imagery.

And if that weren't enough, the doctorate work hinges on a one-shot, all-or-nothing, minutes-long payoff. Jones' thesis work – from designing, building, testing and calibrating instrumentation to analyzing and interpreting flight data – rides on a successful 18-minute

flight into the ionosphere. But what a payoff it is, notes rocket scientist Marc Lessard, Jones' advisor.

"The great thing about NASA's rocket program is that it provides really excellent training for graduate students," Lessard says. "It's a three-year program and Sarah hit it just right. She's got the bulk of her courses behind her, and now she's working on the instrument development, rocket integration, and launch. And, barring complications, she'll get the data and analyze them." Jones' thesis work, in other words, will go from the ground up.

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The aurora borealis is well known and well studied, but pulsating auroras – ephemeral, high-energy patches of light that occur at the end of auroral episodes are not.

Photo © Romko Krochuk

EOS Spheres is published seasonally by the Institute for the Study of Earth, Oceans, and Space at the University of New Hampshire. We welcome comments and suggestions.

Spheres Newsletter
Institute for the Study of Earth, Oceans, and Space (EOS)

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Printed with soy inks on 100% post-consumer recycled paper, manufactured chlorine-free.

A Bird's-Eye View of Avian Flu

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at the FAO and epidemiologist Marius Gilbert in Belgium, MODIS-based rice maps of Thailand in 2004-05 were used for geospatial data analysis of HPAI outbreaks, poultry production system and paddy rice agriculture. The analysis helps scientists understand how the bird flu spreads over space and time in Thailand.

"The key is harvest timing," Xiao explains. "When rice is harvested a farmer will drive hundreds or thousands of the free-ranging ducks into the harvested fields so they can eat the remaining, leftover grains and the insects."

Tracked via remote sensing, the rice paddy harvesting data are put into a risk assessment model to identify where high-risk regions are, and what the high-risk time period is. Knowing all this, public health officials can do targeted sampling and monitoring to control the movement of the free-ranging ducks and, theoretically, the spread of the virus.



Xiangming Xiao

Agricultural expansion has resulted in substantial losses of natural wetlands across the globe. Agricultural intensification (double or triple cropping in a year, irrigation, shrimp and fish ponds) has generated alternative habitats for wild birds. Flooded paddy rice fields become part of the habitat of migratory wild birds during the

winter season. Wild birds and free-ranging ducks mixing together in flooded paddy rice fields increases the likelihood of the virus being spread.

In addition to tracking the spatial patterns and temporal dynamics of agricultural land use, remote sensing techniques are being used to track the migratory movement of wild birds.

From the Director

Celebrating and Accepting Change

I WRITE THIS COLUMN with the very fresh news that President Ann Hart has accepted the presidency of Temple University. During her tenure we have seen UNH cross the \$100 million threshold in annual research funding, with an expanded role of undergraduates engaged in the research enterprise. However, as President Hart departs this campus for another, the uncertain climate in federal research support that has developed of late, particularly in the Earth and space sciences, strongly suggests that future EOS benchmarks in research cannot be taken for granted. As we bid farewell to President Hart we keep a watchful eye on UNH's horizon for leadership that will continue to keep us on the path of excellence in research.

Fortunately, as educators and researchers we have learned to embrace change. By providing for and encouraging growth, change is the very essence of the university-research world. New challenges inspire and innovate, and we will adjust and adapt our education and research mission as necessary to continually capture the interest and imagination of both fellow

scientists and the larger human community.

In this issue of Spheres, we celebrate change in different contexts – the work of fellow colleagues whose public service or investigative research have added to and changed the ever-growing body of knowledge of our dynamic world, and who are also now on the threshold of making significant changes in their own lives.

Professor Joe Hollweg is retiring after three decades of research and teaching and seeking answers to questions about how and why things change in the solar atmosphere. And Amy Frappier, who during her graduate studies here used cave stalagmites in Belize to uncover an extraordinarily valuable historic record of El Niño, one of the central patterns of climate variability and change, now moves on to a faculty position at Boston College.

Congratulations Ann, Joe, and Amy. Stay in touch; the feeling of connection and its importance does not change.

— Berrien Moore III



Because migration of many wild birds is a temperature-driven phenomenon, scientists can use satellites to remotely sense land surface temperature and predict the likelihood of the onset of migration to breeding, molting, and wintering grounds. And, unlike weather station or climate data, which is spotty in many poor and/or remote regions around the globe, satellites can provide broad, high-resolution, real-time temperature data.

Says Xiao, "Remote sensing can also provide area estimates of water bodies and wetlands at breeding and wintering grounds, which can help estimate population sizes of migratory birds." He adds, "So this is all about having geospatial information to do a risk assessment, to help develop the surveillance system, the early warning and early response strategy."

The FAO recently awarded the UNH team with a contract of \$168,000 to integrate remotely sensed data into the FAO's early warning system and decision-support system. Says Xiao, "From May to December 2006 we will develop and implement a prototype tool that enables us to deliver geospatial data in timely manner. That

will facilitate full integration of the satellite-based mapping capacity with spatially explicit epidemiological and risk assessment models."

If all goes according to plan, the scientists will finish up their work in Thailand for the FAO and initiate similar work in China with the Chinese Academy of Sciences. They will also begin to analyze data for Nigeria – the first African country to have seen the bird flu this year.

Xiao notes that, based on their research activities in Asia, they will develop a set of tools to monitor the migration of wild birds and track the spatial spread of bird flu in any complex cropland-wetland environmental setting, including those in the U.S. and Europe.

"We're testing this in the most complex agricultural setting, Asia, and if we can do it well there we believe we can do the same in the U.S.," Xiao says.

For further information on the avian flu and FAO's work, visit http://www.fao.org/ag/againfo/subjects/en/health/diseases-cards/special_avian.html. -DS

STEREO-PLASTIC:

Flight Models 1 & 2 Come Home One Last Time, Then Head to Cape Canaveral

THEY'RE BAAACK! Principle investigator Toni Galvin wisely built a final "refurbishment period" into the project schedule and, indeed, the complex instruments have come back to Morse Hall at the 11th hour.

Both Flight Models 1 and 2 (FM1, FM2) were removed from their respective spacecraft and came home for additional tweaks after shaking at the Johns Hopkins Applied Physics Laboratory and baking at Goddard Space Flight Center.

And so, senior research project engineer John Gaidos sits gazing at a laptop screen as a dizzying stream of numbers whirs by. It's Monday morning. Gaidos, along with the rest of the PLASTIC crew, was here through the weekend. The numbers represent simulated ions being read by FM1, which is being "bench tested" in a clean room just feet away. FM2, on the other hand, is sequestered in the

big vacuum chamber getting blasted with the real thing as it's put through its post-fix paces. Because these instruments have seven high voltage supplies, one producing 20,000 volts of juice, they cannot be operated in air for fear that an electrical arc will blow some delicate component to smithereens.

"This whole thing was an unplanned removal from the spacecraft, but there were other instruments that had problems during thermal vacuum testing that also had to come off," Gaidos notes. "It's not uncommon but you don't like it when it happens. It causes a lot of stress for everyone," he says with a fatigued grin. He adds, "It's the absolute application of Murphy's Law." Indeed, Galvin notes, "Murphy has been an unfunded Co-Investigator on our project!" But in the end, both instruments and the entire STEREO-PLASTIC team survived the rigorous testing. Next stop, outer space, for the instruments that is. -DS 🌌



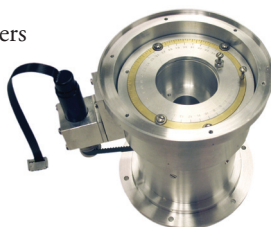
John Gaidos, left, and Stan Ellis benchtest PLASTIC Flight Model No. 1

Spin Doctors

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A 2006-07 Space Grant fellow, Jones is working with Lessard on the Rocket Observations of Pulsating Aurora (ROPA) project, which aims to launch a sounding rocket from Poker Flat Research Range north of Fairbanks, Alaska in January 2007. Jones is doing the mechanical design of a very special low-light, charge-coupled device or CCD camera – that must rotate, of course. On the project, Jones works closely with SSC electrical engineer Paul Riley, whom Lessard calls "a magician."

Pulsating auroras are not the familiar, shimmering arcs of the Northern Lights or aurora borealis. These auroras also fill the night sky but are circular patches typically just 50 kilometers big, last only seconds, and occur during the early morning hours at the tail end of the sweeping auroral events.



Despite their small size, transient nature, and distance 100 kilometers above the surface of the Earth, pulsating auroras pack an energetic punch according to Lessard, who has seen their very strong electrical signature recorded on ground-based induction coil magnetometers. But just what causes these little, high-energy events is poorly understood and understudied.

For the launch slated for next January, Lessard, Jones, and collaborators from Dartmouth



Marc Lessard and Sarah Jones with the imager they've designed to fly on a sounding rocket.

College and Cornell University, will send up a 60-foot, four-stage rocket that will go through a series of complicated "gymnastics" to image auroras and measure the associated electrical activity. "It's pretty complicated," Lessard says of the rocket's trajectory, which will provide a high-and-wide field of view to study the auroras.

During its flight the spinning rocket will twice be rotated onto its side and eject two "fly-away detectors" 90 degrees apart. These little detectors will rocket themselves away to get good separation for measuring electrical currents. The auroral imager will remain on the main payload and, from a height of 750 kilometers, will have

120 degree field of vision (covering some 1,800 kilometers) of the pulsating auroras about 600 kilometers below. This panoramic view will, it is hoped, provide the scientists with a much better understanding of the distribution of pulsating patches in the ionosphere.

"This is very much an exploratory mission," Lessard says noting that despite years of rocket launches studying auroras under the direction of Emeritus Professor Roger Arnoldy, this is the first time UNH scientists have launched a rocket specifically to study pulsating auroras.

Lessard himself got his start in rocket science working in Arnoldy's rocket program as an undergraduate, and it was the retired professor who urged Lessard, then a research faculty member at the Thayer School of Engineering at Dartmouth, to step in and fill his shoes at UNH. Part of Arnoldy's sales pitch was the fact that maintaining a strong rocket program ensures fertile training ground for graduate students.

"In fact," Arnoldy says today, "You look at the people in space science who are building space hardware now and a good percentage of them, including Roy Torbert, cut their teeth on building experiments for sounding rockets."

Adds Lessard, who notes that two sounding rockets failed in the last two years due to mechanical problems, "This is seat-of-the-pants, low-cost access to space with a relatively high risk but big benefits for graduate students who could never have this soup-to-nuts experience with a satellite mission." -DS 🌌

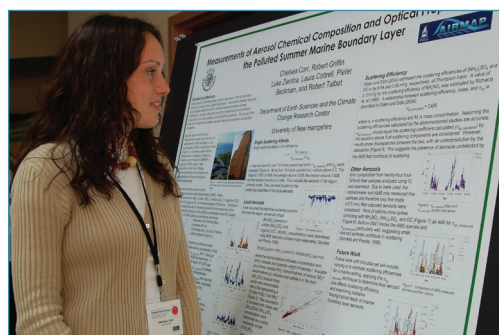
Undergraduate Research Shines in Morse Hall

PERHAPS BERRIEN MOORE, director of the Institute for the Study of Earth, Oceans, and Space (EOS), said it best. As the awards ceremony for the Interdisciplinary Science and Engineering Symposium drew to a close April 26 in Morse Hall, Moore noted, "We've presented five awards, but the room is filled with winners, and you are all to be congratulated."

Indeed, given the fact that more than 108 young men and women presented 62 research projects with titles ranging from "Kolmogorov's 4/5 Law and its Magnetohydrodynamic Analogues in the Solar Wind" to "Measurements of Aerosol Chemical Composition and Optical Properties in the Polluted Summer Marine Boundary Layer," picking but five "winning" projects must have given the judges fits.



Joe Klewicki and Ben MacBride.
Photo: Perry Smith, UNH Instructional Services



Chelsea Corr

"The ISE judging was very difficult," says David Bartlett, EOS associate director and one of the judges for the 22 science posters (as opposed to a larger array in engineering fields). "For the most part, I thought the posters were of graduate-student quality and sophistication, and so choosing winners often came down to fine-level impressions of presentation quality and the like," he says.

John Aber, UNH vice president for research and public service, noted that the university's showcasing of undergraduate research through the weeklong Undergraduate Research Conference, of which the ISE event is part, has become a "signature event" and that students "really put their hearts and souls" into their research work. "Whenever we want to show our best," Aber said, "we put our students up front."

Among those up front were mechanical engineering major Michael Borrelli and physics majors George Clark and Morgan O'Neill. The three designed and tested a star sensor for the Interstellar Boundary Explorer mission instrument currently being developed in the Space Science Center. The star sensor project was one of five chosen by judges as an ISE award winner.

"The star sensor needs to track stars accurately enough so that we can overlay the data we get from IBEX onto a map of the sky so we know where particles are coming in from," notes O'Neill. Those particles are the quarry of the IBEX-lo camera. "Our data gathered from simulations so far have been really good," O'Neill adds.



Eberhard Möbius and Vasily Vorotnikov
Photo: Perry Smith, UNH Instructional Services



Paul Bruillard

Assistant professor George Hurtt, chair of the ISE symposium, said the event built impressively on events from the past two years and involved 20 departments and four colleges from across campus. In addition, there were more than 15 programs at UNH providing information to students about possible next steps to take in their educational careers, Hurtt noted.

"I think the conference was the best yet, and the students continue to inspire me. The scientific questions of the future will not be the same as the questions of the past. The interdisciplinary strengths of these presenters, and this university, are on the right track to preparing researchers to address the questions ahead."

For more on URC and ISE participants and winners, visit <http://www.unh.edu/urc>. -DS

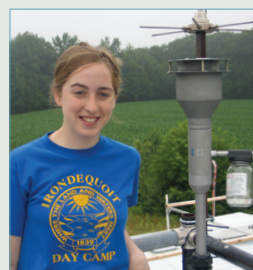
Student News

Qingyuan Zhang received an Outstanding Student Paper Award from the American Geophysical Union at the 2005 Fall Meeting. His paper was entitled "Characterization of seasonal variation of forest canopy in a temperate deciduous broadleaf forest using daily MODIS data." Zhang graduates in May with a Ph.D. in Natural Resources and Environmental Study.

M.S. students **Tracey Wawrzeniak** and **Gerry Hornok** will present their ice core research at the spring meeting of the AGU this month in Baltimore. Wawrzeniak's oral presentation is titled, "The Spatial and Temporal Variability of the North Atlantic Oscillation Recorded in Ice Core Major Ion Time Series." Hornok presented "Glaciochemistry of an ice core from the Tien Shan: Tracking environmental change in central Asia."

Shannon Buckley, who has been working in the Climate Change Research Center during her entire undergraduate career, graduates in May and will be attending Columbia University's Climate and Society master's program. "Working with CCRC over the last four years has definitely shaped my academic interests and career goals. It has provided me with an immeasurable amount of experience," Buckley says.

Physics major **Michael Antosh**, a junior from Wakefield, R.I., won a



Shannon Buckley

Barry M. Goldwater scholarship. Antosh worked on IBEX simulations fall 2004 through spring 2005. **Benjamin MacBride** of Stratham, another physics junior, received a Goldwater Honorable Mention. MacBride has been working with Chuck Smith on several projects. Scholarship winners are selected on the basis of academic merit from a field of 1,081 mathematics, science and engineering students nominated by the faculties of colleges and universities nationwide.

Kyle McLaughlin, a mechanical engineering student working with Jim Connell, has won an UROP Student Undergraduate Research Proposal (SURF) award for this summer. The project title is "Mechanical Housing for ADIS System."

Still Pondering Our Star, Joe Hollweg Heads into the Sunset

IN THE LATE 1960s, when Joe Hollweg began his career studying the dynamics of the solar atmosphere and wind, there was talk about building a solar probe spacecraft that would one day fly in close to the surface of the Sun to gather critical data about the workings of our star.

Says the astrophysicist, “I remember saying, ‘Gee, I sure hope we get a solar probe launch before I retire.’” Close, but no cigar.

Today, after 26 years of research and teaching as part of the Solar-Terrestrial Theory Group within the Space Science Center, Hollweg is heading off into the sunset, but his swan song is the same song, second verse. “Now I want to see the solar probe before I die,” he says with a laugh.

The dream did become reality, sort of. NASA’s Solar Probe, which is designed to fly into the Sun’s million-degree atmosphere or corona, made it off the drawing board to become a real mission. “But,” Hollweg says, “it’s been up and down for a decade. The mission is very difficult to do and very expensive.” If Solar Probe ever does fly it could provide a wealth of *in situ* information that Hollweg and scientists of his ilk have coveted for years.

The bulk of Hollweg’s career has been devoted to answering questions related to the broad scope in the energy and momentum balance of the solar atmosphere and the solar wind – questions for which the Solar Probe might possibly provide vital clues. “What makes things move, what makes things hot, where’s the momentum come from, where’s the energy come from?” Hollweg asks.

There are still plenty of fundamental questions to be answered about some of the Sun’s exotic, even counter-intuitive behavior. But it’s not for a lack of trying on the part of Hollweg and his colleagues.

For example, back in the early 1980s, Hollweg tackled the problem of why heavy ions in the solar wind flow faster and hotter than the lighter protons in the mix of solar wind particles. “Something exotic must be happening in order for this to occur,” he says. So Hollweg, an old-school, paper-and-pencil theorist, paired up with colleague Phil Isenberg to plug these quirky ions into a full-blown model of the solar wind and put in some of the wave processes they thought were working.

Hollweg recalls, “Right off the bat we discovered that nobody had written down the equations for how the waves propagate when you have

multiple ions moving at different speeds. So we had to derive the basic equations we needed for the model.” He adds, “It was really a complicated thing but I still think that’s one of the best things I ever did, and it wouldn’t have been done without Phil.”



Shortly after this picture was taken in Positano, Italy in 2005, Hollweg had a “eureka” moment while riding a train. He realized a vexing problem could be solved without doing a lot of “mathematical shenanigans.”

Solving fundamental problems, doing basic physics is perhaps one reason why the Solar-Terrestrial Theory Group has had remarkable success through the years obtaining consistent funding from NASA for its work. The Solar-Terrestrial Theory Group, now under the umbrella of the Space Plasma Theory and Simulation Group, is comprised of Marty Lee, Terry Forbes, Phil Isenberg, Bernie Vasquez, Yuri Litvineko, and Sergei Markovskii. (<http://reconnection.sr.unh.edu>)

Another source of professional pride for Hollweg is work he and Isenberg did on predicting something verified only a few years ago by the Solar and Heliospheric Observatory (SOHO) spacecraft. Through number crunching and modeling, Hollweg and Isenberg tried to figure out why the solar wind goes as fast as it does – another vexing problem that doesn’t make sense from a physical standpoint. Their results predicted very hot protons close to the Sun in the region where the solar wind was speeding up. And yet, the observational data at the time said, sorry, no hot protons out there.


“Then, five years later in 1995, they launched SOHO and it had an instrument onboard that found hot protons next to the Sun just as we had predicted.” He adds, “That’s always something I’ve been proud of. It’s not too often you make a prediction that turns out to be true.”

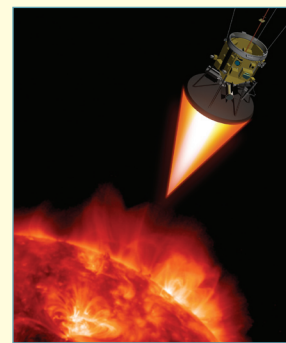
Although Hollweg, a thick mane of salt and pepper schoolboy hair combed across his forehead, looks anything but old, he admits he doesn’t have the physical stamina he once possessed to practice his craft. “Years ago I’d do 300 or 400 pages of mathematics and not make a mistake, but now I just can’t do it because it requires so much concentration. I just don’t have the nerves for it anymore,” he says.

Hollweg might not only be called old school but also “low school” as he has a penchant for boiling tough mathematics down to as elementary a level as possible when attacking physics problems. He attributes this approach to his training as an engineer, keen physical intuition, and less-than-stellar math skills. “My math was never that good so if I could find a simple way to do something using freshman physics I’d feel much happier,” he says.

His modus operandi has not gone unrecognized. Hollweg was awarded the 1992 James Arthur Prize for Solar Physics by the Harvard-Smithsonian Center for Astrophysics, and in 2002 was elected Fellow of the American Geophysical Union “for outstanding research on topics throughout the corona and solar wind and for consistently clear elucidation of the fundamental physical processes involved.”

But now Hollweg’s happy to wind the physics down and travel more. “For most years of my career, I’d be hiking in the mountains or taking the dog for a walk in the evening and still the physics would be churning in my head. Now that doesn’t happen very much any more, and I figured once that went away maybe it was time to retire,” he says.

After a quarter of a century trying to decipher what makes the solar wind go so fast, what keeps it hot, what makes ions like iron and helium go faster than protons, how much has Hollweg’s field of science changed? “In some ways not that much,” he says. “We’ve made some good progress but nobody’s gonna put it in an encyclopedia and say, That’s it.” He adds, “We’re never going to nail some of this down until we go closer to the Sun with a spacecraft.” -DS 



Artist’s conception of the Solar Probe. Courtesy of the Solar Probe Science and Technology Definition Team and the Johns Hopkins Applied Physics Laboratory.

From Caves to Classroom

A freshly minted Ph.D. in hand, Amy Frappier moves on to teach at Boston College

WHEN AMY FRAPPIER arrived at UNH in the fall of 1999, the Climate Change Research Center (CCRC) was heavy into paleoclimate-ice core research. Frappier was interested in pursuing paleoclimate work for her master's degree but wasn't wild about working in polar regions.

"I had been to Antarctica. Fascinating place, but no one lives there, Frappier says. "I am more interested in tropical regions, where most of the people on the planet live."

As luck would have it, at the time she arrived on campus another UNH master's student was investigating how climate might have affected the rise and fall of Maya civilization.

"Eric White was doing this really interesting project working on stalagmite records from Belize, which I knew almost nothing about, but it was in the tropics," Frappier says. "So I did some investigation and found that it might be possible to pick out hurricane events in stalagmites using stable oxygen isotope ratio analysis, which I knew a little something about from my undergraduate work."

Knowing that an accurate record of past hurricane activity would provide one more piece in the puzzle of climate change-global warming, she dug further and discovered that the oxygen isotope ratio analysis had indeed been tried years before. However, the techniques used to analyze stalagmites at high-enough resolution to actually pick out something as brief as a hurricane rain event had not yet been developed, and so that research had come up empty. But in another bit of happy circumstance, Frappier recalls, "New techniques had just been recently developed, and I realized this would give us another chance." Frappier took the chance, and it paid off in spades.

Not only did the new technique work but Frappier made a most surprising and important discovery using a stalagmite from the Cave of Stone Tomb in Belize. Initially looking for evidence of past hurricane activity, upon analyzing the stable isotope data contained within the stalagmite, Frappier noticed a big jump in carbon isotopes during an El Niño year. A harder look at the data revealed the entire graph for carbon matched up with historic records of El Niño events.

Along with her collaborators in the work, Frappier, who now calls stalagmites the "ice cores of the tropics," published the findings in the journal *Science* in October 2002. She was 25 years old at the time.

Achievements like this, along with series of fellowships (including a NASA Earth System Science Fellowship 2003-06 and a Space Grant fellowship 2000-01), a string of honors and awards, and professional and teaching experience, no doubt opened some eyes and doors at Boston College. Not to mention the unexpected timeliness of her hurricane research. After completing her doctorate this summer, Frappier will join the faculty in Geology & Geophysics at Boston College in the fall. Says Frappier, "I feel very fortunate."



Amy Frappier wades through the lower river passage in cave Actun Tunichil Muknal in Belize to her study site. Photo © Stephen L. Alvarez

In addition to a fully developed program in stable isotope-paleoclimate research and plans to expand her research beyond Belize, Frappier will take some strong teaching tools with her, thanks in part to the minor in college teaching she pursued at UNH.

Says Frappier, "The Preparing Future Faculty Program helped me to develop as a teacher and think about how my students are learning. Hopefully this all translates into students being able to learn in a deeper, more effective way."

An active research program is, Frappier believes, a critical component of helping engage students and creating a richer teacher-student experience.

"I believe I'll be able to bring in a lot of the latest problems and questions from my field of research," she says adding, "and I like to be able to communicate not just what we know, but also the fact that there are a lot of important unsolved questions that need talented people to work on."

Frappier adds that her focus on college teaching, in tandem with her Ph.D. research, should help her to avoid adopting a "sage on the stage" teaching style.

"That's when the instructor gets up there and talks at you and you're supposed to somehow receive all this profound knowledge. I never enjoyed that much while a student and don't think it's very effective. Just because you're an expert at research doesn't mean you're an effective communicator," Frappier says. "I still have a lot to learn as a teacher, and I'm looking forward to spending time with students in the classroom, field, and lab at Boston College." -DS 🌍

Faculty/Staff News

Scott Ollinger received a two-year grant from the Northeastern States Research Cooperative (NSRC) to study the effects of climate change on northeastern forests.

Eberhard Möbius reports that the Engineering Test Unit of the IBEX-lo time-of-flight spectrometer has been completed and will next go to the University of Bern for testing with their prototype of the remainder of the sensor. Möbius also gave an invited presentation on imaging the boundary of the heliosphere with IBEX at the American Physical Society Meeting in Dallas in April.

Cameron Wake was a co-convenor of the North Pacific Climate Workshop with colleagues from the Geological Survey of Canada, Audrey Dallimore and David Fisher. The workshop was a follow-up to a session presented by the three at the Fall 2004 AGU meeting in San Francisco entitled "Paleorecords of North Pacific Climate Variability."

Climate Change Research Center's education coordinator **Erik Froburg** has written and produced a podcast entitled "ClimateCast" available from AIRMAP's homepage (<http://airmap.unh.edu/outreach/ClimateCast>). The podcast is hosted by CCRC's **Pieter Beckman**. Each episode focuses on a specific aspect of climate or atmospheric research and includes interviews with CCRC personnel.

Breaking New Ground in Coastal Ocean

THE NORTHEAST'S very first coastal ocean carbon dioxide (CO₂) buoy will soon bob about in the waters off Appledore Island at the Isles of Shoals thanks to a collaboration between NOAA and the UNH Joint Center for Ocean Observing Technology or JCOOT.

Among JCOOT's goals is an effort to establish the Isles of Shoals Observatory as a test-bed facility for infusing new observing technology into the Gulf of Maine regional observing network.

"One of the things the joint center does is bring new technology to bear, and this will be the first time we've had a time-series measurement of CO₂ out in the Gulf of Maine," says Douglas Vandemark, a scientist from the Ocean Process Analysis Laboratory (OPAL) and co-investigator involved with the nascent cooperative, interdisciplinary center. Berrien Moore is the director of JCOOT, with Janet Campbell (OPAL) and Robert Talbot (CCRC) as co-directors. The joint center also targets "making innovative use of existing ocean, land, and atmosphere observing systems."

NOAA's Pacific Marine Environmental Laboratory (PMEL) has been making CO₂ measurements in open ocean waters of the equatorial Pacific for a number of years under its Carbon Dioxide

Program. Only now will the agency begin to investigate coastal waters. And, says, Vandemark, "Our buoy will be the first to get wet" as NOAA develops a network of CO₂ buoys to make high-resolution time-series measurements in the global ocean. Time-series measurements of ocean carbon and air sea exchange help provide information on carbon cycle variability on time scales ranging from hours to years.

Carbon cycling on the continental margins is poorly understood and under sampled. Because of this, it is uncertain whether these regions are a net sink or a net source of CO₂ to the atmosphere. In contrast to open ocean waters, coastal ocean regions occupy a relatively small area but are the active interface between the terrestrial and marine environments. Coastal environments directly interact with terrestrial air masses, and because of their sensitivity to changes in wind, river runoff, and anthropogenic inputs of nutrients and carbon, they are likely to be very sensitive to climate change.

The buoy uses a CO₂ sensor developed by NOAA-PMEL and repackaged to assess its application to coastal work by UNH scientists and JCOOT collaborator Jim Irish of the Woods Hole Oceanographic Institute. Vandemark is working with PMEL's Chris Sabine, lead scientist for the Carbon Dioxide Moorings Program.

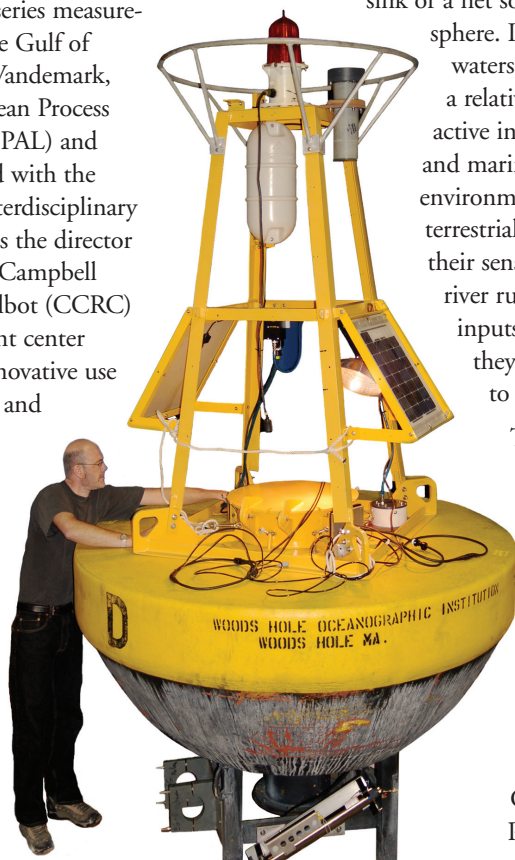
The buoy system off Appledore will bubble CO₂ out of the surface water into its gas phase and make a measurement. Then, using a sensor atop the buoy, the system will switch over and measure atmospheric CO₂ as well. This air-sea CO₂ exchange is one of the big questions the buoy data will go after, and this is an example of the joint center's interdisciplinary approach.

UNH's five regional observing stations operated under the AIRMAP program (www.airmap.unh.edu), another joint UNH-NOAA venture, have picked up a lot of marine signatures in the air quality measurements made even at locations far from island sites. In order to understand the complex dynamics of air-sea exchange, scientists need to know the details of atmospheric gases dissolved in the ocean surface layer.

Bob Talbot, director of AIRMAP, notes that the CO₂ work being done by AIRMAP, JCOOT, and another NOAA-affiliated program, the Northeast Center for Atmospheric Science and Policy (www.ncasp.org/index.html), "will provide us with a much clearer picture of carbon dioxide dynamics in a regional perspective – from the ocean surface up to 2,500 feet above ground."

Says Vandemark, "We're interested in how much CO₂ the ocean takes up. That's another question this data is for. And we want to know how this uptake is changing with time." Over the next decade or decades, data like that being gathered by this and additional moorings will be included in models of CO₂ exchange between the ocean and the atmosphere and help answer how that component of the Earth system is working.

Look to future issues of *Spheres* for more on JCOOT projects as they develop. More about the joint center is available at <http://www.jcoot.unh.edu>. Information about NOAA's carbon dioxide program can be found at <http://www.pmel.noaa.gov/co2/co2-home.html> -DS



Doug Vandemark readies the buoy that will measure coastal ocean carbon dioxide levels for the first time in the Gulf of Maine.

■ Earth Science

Watching the River (of Ice) Flow

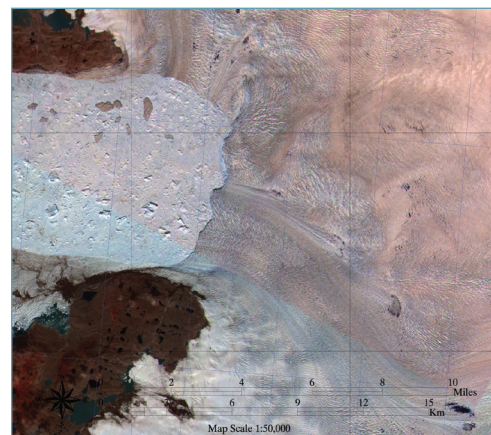
COMPLEX SYSTEMS RESEARCH CENTER glaciologist Mark Fahnestock is currently in Greenland at the Jakobshavn Isbrae glacier with colleagues from Alaska hoping to gain insight into what has caused the glacier's movement to double in speed over the last five years. They will do this by deploying Global Positioning System (GPS) receivers that will "ride" the ice sheet for the summer season and longer.

The objective is to measure in detail the ice flow speed, the rapid rate at which that speed changes, and how it is influenced by tidal cycles

in the ocean and increased melt water atop the ice sheet during the course of the summer.

"Several of the big outlet glaciers in Greenland have been speeding up and dropping more icebergs into the ocean and retreating at the same time. That was the motivation for us to go in and take a harder look at Jakobshavn as it does this," Fahnestock says.

In the end, the scientists hope to decipher how much the glacier will change over time, and how much additional ice will end up in the ocean affecting sea-level rise and potentially impacting ocean circulation due to changes in salinity. -DS



The area of Jakobshavn Isbrae glacier in Greenland where Mark Fahnestock and colleagues will deploy GPS monitors on the ice to measure its rate of flow.



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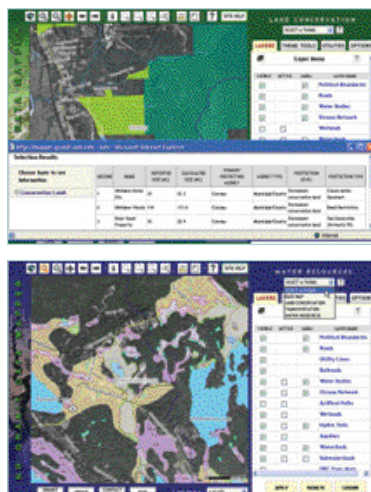


NH GRANIT Produces Web-based Mapping Tool

The New Hampshire Geographically Referenced Analysis and Information Transfer System's (NH GRANIT) new mapping tool (pictured) makes the statewide geographic database available over the web.

The NH GRANIT Data Mapper offers communities, agencies and organizations, and the general public access to the system's comprehensive collection of archived geospatial data—such as town boundaries, lakes and ponds, roads, wetlands, soils, conservation lands, and aerial imagery. Data and the related tools are designed to inform and expand decision-making at the local, regional, and statewide levels.

The Data Mapper was developed by NH GRANIT staff in the Complex Systems Research Center in collaboration with the UNH Research Computing Center. The primary objective of the site is to support communities by providing maps and analyses typically incorporated in community master plans. It will also assist local land use boards, including planning boards and conservation commissions, who need access to mapped information in order to respond to the issues and challenges they confront. To use the new GRANIT tool and learn more, visit <http://mapper.granit.unh.edu>. -DS 



FALL 2006 EOS COURSES

EOS/Phys 895. Space Instrumentation

Modern space-based instrumentation provides extremely sophisticated and exciting measurements across a broad range of scientific disciplines. This course will explore a selection of state-of-the-art instruments, and their design challenges, for both *in situ* measurement and remote observations.

EOS/ESci 817. Macro-scale Hydrology I

Focuses on the numerous roles of water in the Earth system. Topics include the global water cycle, impacts of the greenhouse effect and other anthropogenic disturbances, hydrologic modeling, soil-vegetation-atmosphere transfer schemes, water quality, GIS and water-related remote sensing tools.

EOS/NR 867/ESci 895. Earth System Science

Introduces the major components, interactions, and concepts for characterizing the modern Earth system, e.g., spheres, cycles, energy balance, equilibrium, feedbacks, linear and non-linear dynamics.

EOS 895. Advanced Remote Sensing Methods for Earth System Research

Focuses on learning analytical methods for using regional-to-global scale remote sensing data to study the Earth system. The tools and techniques of remote sensing will be discussed with the aim of developing the skills required for future research on a variety of topics.

EOS 995. Regional Air Quality

A review of measurement programs focused on examining air quality in various atmospheric regions of the globe with particular emphasis on New England. Sources of data will be identified from measurement campaigns, emission inventories, and meteorological information.

On the Web at <http://www.eos.unh.edu/grads/eoscourses.shtml>.